# Chapter 15

# Field Procedures for Skeletal Remains

Hundreds of studies about human osteology are published each year, ranging from announcements of fossil discoveries (*e.g.,* White et al., 2009) to comprehensive treatments involving multiple populations (*e.g.,* Larsen, 2006). All these studies begin with fieldwork. This chapter introduces procedures useful in recovering skeletal material. The chapter is organized in an approximately chronological manner. We first review aspects of discovery, involving techniques of retrieval and excavation. Then we discuss the transport of skeletal material. Laboratory procedures and reporting are covered in Chapter 16.

Common sense is critical in every aspect of osteological analysis, whether in the field or in the laboratory. If there is any one overriding rule, it is this: *think twice before you act.* There is no single formula, recipe, or procedure to apply in every field situation. There are simply too many different discovery contexts, and there is too much variation in preservation involving osteological remains. Cemetery excavation is different from isolated skeleton excavation; fossil bones are different from modern ones; forensic cases are different from archaeological projects; and waterlogged burial conditions are different from mummified remains in the driest deserts. There are, however, some general principles that apply in most instances where skeletal remains are concerned.

In forensic investigations involving osteological remains, there are usually official government protocols that must be followed. For example, the Joint POW/MIA Accounting Command (JPAC, known until November, 2003, as CILHI, the Central Identification Laboratory, Hawaii), the Armed Forces Medical Examiner (Armed Forces Institute of Pathology; AFIP), and the Federal Bureau of Investigation all use written guidelines for the handling of human remains. Often called "SOPs," these are Standard Operating Procedures that govern how osteological materials are treated by personnel. Usually these remains (usually defined as any human biological tissue that is not normally or voluntarily shed) constitute evidence. The purpose of formalized procedures is to ensure the integrity, maintenance, and security of that evidence. The procedures often included in SOPs relate to scenes, sampling, laboratories, reporting, storage, equipment, and safety. The osteologist should become familiar with these official protocols and procedures whenever involved in a forensic investigation. Skinner and colleagues (2003) provide very useful and comprehensive guidelines for osteological work in modern forensic settings, particularly those involving mass graves, and Blau and Ubelaker's (2009) book provides a wide overview of osteological forensics.

## 15.1 Search

Osteological remains may be discovered in forensic, archaeological, or paleontological contexts either as a result of intentional professional or amateur survey, or as a result of accidental discovery. Intentional search methodologies vary widely, from paleontological expeditions to murder or missing person investigations. Sometimes the search is large-scale, aimed at recovery of scattered hominid remains in large fossil fields such as Ethiopia's Middle Awash study area (see Chapter 28). Other times, the search can be very localized, as in the charred rubble of the Branch Davidian Compound in Texas (Owsley et al., 1995), or on a larger scale, as in the search for military MIAs within decades-old craters created by high-speed military aircraft impact (Hoshower, 1998). The application of a variety of remote-sensing technologies to forensic investigations is reviewed by Davenport (2001) and Buck (2003), archaeological survey methods are reviewed by Banning (2002), and Parker Pearson (2001) gives a cross-cultural overview of the archaeology of death and burial. The edited volume by Adams and Byrd (2008) presents a wide variety of case studies and protocols involved with recovery, analysis, and reporting of commingled human remains in different contexts.

Sometimes remains from archaeological or historical cemetery contexts may be brought to the attention of law enforcement agents or medical examiners as a result of vandalism or natural causes (Berryman et al., 1991). Other times, forensic osteologists are involved in the search for clandestine graves using methods ranging from aerial photographs to trained scent-detection dogs (France et al., 1992, Komar, 1999). Of course, not all searches result in discovery, and many paleontologists return empty-handed. Garrison (2003) provides a useful, broad overview of geoarchaeological contexts in which virtually all osteological remains might be recovered, and Connor and Scott (2001), Haglund (2001), Crist (2001), and Owsley (2001) review the ways in which archaeology can assist in forensic investigation. Steadman (2009) provides an overview of searching in forensic anthropology. Search methods will vary widely in osteology depending on the unique context of each case, but once discovery is made, a general series of steps in the assessment, documentation, extraction, and transport of the remains is set in motion.

## 15.2 Discovery

Skeletal remains are often found by accident. For example, hikers and construction crews often find osteological material. When they do, they usually report it to local law-enforcement authorities. There are many more dog, horse, cow, and goat bones than human bones on the surface of most landscapes, and these are often mistaken for human bones by laypersons and amateurs. A general rule for the practicing human osteologist is to assume that law-enforcement personnel who often first encounter such remains (including, in some cases, coroners) are not qualified to render accurate opinions on isolated, fragmentary skeletal remains. For example, we have seen cases in which a pet rabbit that perished in a trailer home fire was identified by the official coroner as a human infant, or where a portion of a melted fiberglass shower enclosure was identified as a charred human 'hip bone.' Forensic human osteologists usually encounter situations in which morphological identification is easily accomplished (for an exception, see Ubelaker et al., 1991). However, a coordinated effort between physical anthropologists and law-enforcement specialists at a crime scene is absolutely essential for the recovery of all available clues (Wolf, 1986; Maples and Browning, 1994; Dirkmaat and Adovasio, 1997).

Upon being introduced to skeletal material, the osteologist is faced with three critical questions:

- Is the material human?
- How many individuals are represented?
- Of what antiquity is the material?

Experience is the most valuable commodity in answering the first two questions. When in any doubt, consult comparative skeletal material or the illustrations in this volume.

The third question is usually more difficult to answer accurately, particularly if contextual information is not available. It is almost always necessary to engage in some detective work to give an accurate answer. The condition of bones themselves does not tell very much because the physical condition of the bones is largely controlled by the physical environment in which they were deposited or exposed. Bone weathering and deterioration are accelerated by direct sunlight, high heat, fluctuating temperature and humidity, biotic influences, and soil acidity. When these variables are held to a minimum, bone deterioration can progress very slowly.

To assess the antiquity of skeletal remains (not individual age at death), it is necessary to give primary consideration to their context. Has the skeleton been recently disturbed? What kinds of artifacts appear with the remains? False teeth, dental fillings, coins, beads, pottery, coffin nails, and other evidence of material culture (if real association can be established with the skeletal remains) may be critical in determining the antiquity of the remains. Wear of the teeth can sometimes provide clues to the origin of the skeletal material; in many parts of the world, the teeth of recently deceased individuals usually show far less wear than that seen in remains of people aboriginal to the area. Because contextual information is so critical to the accurate determination of the antiquity and origin of skeletal remains, the osteologist should always make every effort to visit the discovery site and make a firsthand assessment and record of the depositional history and associations of osteological material.

## 15.3 Excavation and Retrieval

Proper evaluation of any skeletal remains normally requires collection of the bones and subsequent laboratory analysis. Research parameters should be established prior to fieldwork in a well-thought-out research plan that covers as many contingencies as possible. The plan should incorporate the following steps that proceed from discovery:

- It is critical to establish which authorities to contact as well as to prepare a list of additional experts that may be consulted (*e.g.,* geologists, soil specialists, and conservators).
- Excavation and field recording methods should be thought out ahead of time. The research plan should outline both the short-term and long-term disposition of any recovered remains: will the remains be taken to a museum, laboratory, or other repository?
- Are there any legal requirements concerning the reburial of any remains found? In cases where reburial may be required, information sharing and negotiations should be undertaken very early — before any remains are found — to work out the details concerning potential joint curatorship arrangements, and/or any limits to be placed on analysis.

Upon discovery, the osteologist's natural inclination (particularly when the remains were the object of a search and especially if they are hominid fossils) is to collect them. This immediate separation of the specimen from its context should be the choice of last resort. There is no need to rush the removal; the bones can no longer "walk away" on their own. Before disturbing the context, move away from the site and carefully develop a strategy for recording and recovery. If celebration of a paleontological discovery is called for, hold it away from the site. Keep nonessential personnel off-site. On the site, it is advisable to show patience and restraint, while thoughtfully devising an appropriate strategy to extract the remains and all contextual information. Writing impressions down in the form of field notes is necessary and helps in this planning.

After the thrill and excitement of discovery have abated, it is time for serious, objective assessment of the situation. The following questions should be carefully considered before further excavation is undertaken.


Figure 15.1 **A pioneer burial from near the historic Bordeaux Trading Post, southeastern Wyoming.** The grave, which seemed to be associated with the trading post, or the nearby Oregon Trail, was found in 1980 by a field archaeology crew under the direction of George Zeimans and George Gill. *Left:* oblique view of the grave, outlined by the perimeter of the darker infilling soil. The right ulna is exposed near the upper end of the grave filling. *Right:* the grave after excavation (from Gill et al., 1984). Seen in this photograph are the remains of boots and a wide-brimmed black hat over the face. A displaced fragment of right radius is pedestaled next to the right patella. Artifacts found with the skeleton include a wedding ring, an adjacent black ring of mourning, and three coins.

- What are the political and legal constraints under which recovery must proceed? Goldstein (1995) provides an illuminating case study in this regard. Osteologists should confer with project management to ensure that all applicable laws are followed and all concerned parties are informed. In some archaeological and some forensic investigation scenes, hazardous materials will play a role in conditioning how the excavation and retrieval proceeds.
- In what condition is the bone?
- What has happened to the bone as it has been exposed? How has natural or human-induced erosion uncovered and scattered the bone across the landscape?
- What contextual information is available?
- What options are there for recovering the bone? Consider the available time, labor, and equipment. As Hoshower (1998) notes, flexible excavation strategy is a key component of successful recovery.

Figures 15.1 through 15.12 illustrate some aspects of skeletal recovery in archaeological situations. Mays (2010) and Ubelaker (1999), are good sources of additional illustrations, and Chapters 23–28 present case studies that involve the recovery of skeletal parts. Chapter 22 reviews special considerations involving preservatives, biomolecular sampling, and precautions.

Figure 15.2 **Frontal view of the frontiersman's skull excavated from the grave shown in Figure 15.1**. Note the cranial gunshot wound caused by a .44- or .45-caliber weapon. A second perimortem gunshot wound to the hip and at least three healing rib fractures were noted by the investigators. This individual, a male who probably lost his wife prior to his own death (indicated by the black ring next to the wedding band), most likely was shot in 1869 or 1870 (from Gill et al., 1984).

The following general steps should be taken in the recovery of skeletal material:

- If skeletal parts have been scattered by erosion, mark each with a pin flag and assess the distribution to predict where more pieces might be found.
- The overriding concern in all work subsequent to the discovery of the specimen is to allow no further damage to occur. Damage of osteological remains due to improper excavation and extraction techniques is common, but it can be avoided. Steps should be taken to stabilize fragile bone *in situ* (in place) with **consolidants**, if necessary.
- Lose as little information as possible, especially concerning **context**. The remains, whether in a forensic or an archaeological context, are one-of-a-kind. They are nonrenewable resources. There is only one such bone, individual, burial, or cemetery, which means that there is only one chance to extract the remains completely and correctly. Actions taken during recovery have consequences that long outlive any investigator, rendering the osteologist's responsibility a weighty one.
- For articulated primary interments, it is often advisable to take samples of matrix from the chest and abdominal areas to retrieve incompletely digested foodstuff and/or evidence of gallstones or invertebrate infestations.
- Obtain proper equipment for recovery. Table 15.1 is a supply and equipment checklist that osteologists may find useful to consult before heading into the field. Provided that the bones and their context are not immediately jeopardized, recovery should be delayed until the proper tools are available. Use your judgment about how precarious the situation is.
- Before disturbing the scene, make comprehensive written and photographic records of the remains, their distribution, and their context. Never rely on memory. You should establish a site datum (a permanent reference point from which measurements are made) to control a grid laid out with stakes and cord across the surface. All recovered objects can be related to the grid. Manhein et al. (2006) and Listi et al. (2007) consider Global Positioning System (GPS) and Geographic Information System (GIS) approaches to recording


Figure 15.3 **Prehistoric archaeological site in northern California, before and after excavation**. *Left:* the outlines and darker infillings of circular grave pits can be seen on the floor of the excavation trench. The scales are in inches. *Right:* flexed burials were revealed within the slightly superimposed grave pits of Burial 2. Here, the two individuals in this burial are shown, both flexed. The same large stone appears in the lower left corners of the two photographs.

human skeletal remains, concluding that traditional techniques and photographs are still indispensable for mapping scattered remains. As Differential GPS becomes more available and replicability improves, these electronic tools will have an increasingly prominent role. Wolf's (1986) advice on approaching a crime scene with scattered material as if you were clearing a minefield is appropriate in this regard. In the past, a Polaroid® camera and 35-mm black-and-white film were practical and common solutions. However, digital imaging has largely replaced film in such situations (see Section 16.7). Whether using film or digital photography, or tape or digital recording, always create a backup in case of equipment failure or operator mistake. Small, portable, USB hard drives with large storage capacities are inexpensive and provide ideal primary and backup storage. A scale and directional arrow should be included in all drawings and photographs. Subsequent stages of the excavation should be photographed from as many angles as appropriate. Remove all tools, obscuring roots, and lumps of earth before photographing.

- The key to successful photography is the control of light (see Section 16.7.3). If lighting is a problem, particularly in an excavation, use a white sheet, aluminum foil on cardboard, or a flash attachment to illuminate the specimen. If a specimen is of critical importance, it is good to make a video record of it for teaching, lecturing, curatorial, and forensic purposes.
- Begin stabilization measures if necessary (for information on consolidants, see Section 16.2).
- Collect all bone exposed on the surface, even fragments that do not seem to be hominid. Remove your shoes if necessary and get down on your belly for a close look. Make sure the light is adequate before doing this. It is to your advantage that rains have washed the bone surface clean; as you disturb the soil it becomes more difficult to recognize small bone fragments. Move slowly and carefully, not trampling remains or artifacts underfoot.
- Screen earth from the abdominal region of all skeletons to recover dietary or fetal skeletal


Figure 15.4 **Flexed burial of an adult accompanied by associated funerary objects**. Shell beads adhere to the cranium, stones are in the mouth, and other beads and pendants are seen around the postcranial skeleton. Prehistoric, northern California. The scale is in inches.

remains. Screen all of the loose surface earth left over from each skeleton. A 1.0-mm mesh size (window screen) will recover most important fragments. Water wash excavated material through a screen to make the small fragments more visible and easier to recover. Flotation for paleobotanical remains will be called for in some cases.

- For burials, or other articulated *in situ* material, expose the bones one at a time. In an archaeological context it is important to recognize that there is a very large culturally determined and ethnographically observed range of variation in human mortuary practice. In most cases, however, there are some general kinds of burials to which the osteologist should be alert: a **primary interment** is a burial in which all of the bones are in an anatomically "natural" arrangement. Such burials are sometimes classified according to whether the extremities are extended or flexed. There are no neat categorizations here, and one photograph is worth many words of description. A **secondary interment** is a burial in which the bones of a skeleton are not in a "natural" anatomical relationship, but have been gathered together some time after complete or partial disarticulation of the skeleton and then buried. A **multiple interment** is a burial in which more than one individual is present. These burials include **ossuaries**, burial urns containing more than one individual, and a variety of other possibilities. **Cremation** is a mortuary practice involving the intentional burning of the body. Cremations can often be informative — the less efficient the fire, the more informative the specimen. For more information on burned human remains in a forensic and archaeological contexts, see Schmidt and Symes (2008). Micozzi (1991) reviews mortuary practices worldwide.
- In exposing burials, use appropriate tools and use them carefully. Dental picks are sharp and efficient, but they can easily damage the bone. Wooden or bamboo tools may sometimes be suitable, and a range of brushes of various sizes and stiffness is indispensable. Work from the rib cage outward where possible. Do not use the trowel in a sweeping motion unless you are doing exploratory work. Try to leave bones supported as you clean, exposing the foot and hand bones last. Watch for soil color and texture changes, rodent and root disturbance, mat impressions, rotted vegetation, wood, insect remains, charcoal, and associated artifacts such as lip plugs or beads. Be alert to all soft tissue that might remain, including hair, skin, fingertips (for prints), and ligaments. Write or otherwise record your notes; memory will not suffice. Record angles of flexion, the orientation of the body

Table 15.1 Equipment and Supplies for Osteological Fieldwork

TEAM SUPPLIES & EQUIPMENT

- Travel and excavation permits
- Communications equipment
  - Satellite phone
  - Two-way radios
- Detection equipment
  - Aerial photographs
  - Stereo photo viewer
  - Ground-penetrating radar
  - Metal detector (forensic cases)
- Locational equipment
  - GPS unit and download cable
  - Compass (set to local declination)
- Excavation equipment
  - Site preparation equipment
    - Shovels
    - Picks, axes, and saws
    - Bush clippers
    - Wheelbarrows
  - Grid layout equipment
    - Line levels
    - Twine (yellow or white)
    - Nails or stakes
    - Geological hammer
    - Tape measures
  - Controlled excavation equipment
    - Trowels
    - Buckets and dustpans
    - Digging probes (dental and bamboo)
    - Brushes (various sizes and stiffness)
    - Screens
    - Pin flags
    - Tweezers
  - Site shelter and protective equipment
    - Tarpaulins
    - Ropes
    - Field umbrellas
    - First aid kits
- Documentary equipment
  - Photographic equipment
    - Cameras
      - Digital video
      - Digital still
      - 35-mm film still (as backup)
    - Camera tripod
    - Flash attachment
    - Lenses
    - Remote release (or cable release)
    - Photo information board (dry erase)
    - Photo scales (metric)
    - Neutral (18% gray) card
    - Film and protective film bags
    - Digital media (CF cards, memory sticks)
    - Directional arrow
    - Step ladder
    - Puffer (or canned air)
  - Gaffer's tape
  - Digital audio (or tape) recorder
  - Media
    - Audio and video tapes
    - Film
    - Digital media
- General purpose equipment
  - Tools
    - Pliers
    - Carpenter's hammer
    - Wrenches
    - Cutters, files
  - Tape (masking, gaffer's, transparent)
  - Extra batteries (rechargeable & standard)
  - Solar charger for rechargeable batteries
  - Glue
  - Wire
- Conservation and curation equipment
  - Portable tables and chairs
  - Preservative
  - Solvent for preservative
  - Labeling pens
  - Labeling ink
  - Packing material
  - Containers (boxes, bags, vials)
  - Aluminum foil
  - Tissue paper
  - Wrapping paper
  - Notebooks
  - Writing utensils (waterproof)
  - Acetate sheets
  - Acryloid B-72
  - Irrigation syringes
  - Jacketing supplies
    - Polyethylene cling film
    - Orthoplast® bandages
    - Plaster
    - Water & mixing bowl
- Analytical equipment
  - Munsell color chart
  - Laptop computer(s)
  - Copy of *The Human Bone Manual*
- Food & water, if not available locally

PERSONAL SUPPLIES & EQUIPMENT

- Travel and Administrative needs
  - Money
  - Institutional letterhead and envelopes
  - Travel documents
    - Passport
    - Tickets
    - Health certificate
    - Insurance forms
    - Permission letters
    - Letters of introduction
- Shelter
  - Tent, stakes, and guy lines
  - Sleeping bag and pad
- Hygiene
  - Solar sunshower
  - Towel
  - Toiletries
  - Soap and shampoo
  - Toothbrush and toothpaste
- Medical, prophylactic equipment & supplies
  - Sunglasses
  - Sunscreen, lip balm
  - Medicines
  - Water purifier
  - Insect repellent
  - Extra glasses or lenses
  - Gloves
- Clothing
  - Hat (washable)
  - Bandana
  - Rain gear
  - Weather-appropriate clothing
  - Needle and thread
- Eating and Drinking
  - Canteen
  - Plate
  - Cup
  - Eating utensils
- Personal excavation equipment & supplies
  - Digging instruments
  - Pocket knife
- Personal photographic equipment & supplies
  - Camera
  - Camera media (or film)
  - Camera batteries
  - Flash attachment
  - Lenses
  - Photo background
  - Remote (or cable) release
  - Photographic scale
  - Camera strap
  - Small photo mirrors
  - Lens cleaning fluid and papers
- Personal analytic equipment & supplies
  - Hand lens
  - Caliper(s)
  - Measuring tape
  - Small preparation kit
  - Laptop computer
  - Notebook
  - Writing utensils
  - Calculator and batteries
  - Paper clips
  - Permanent ink marking pens
  - Rubber bands
- Miscellaneous personal equipment
  - Plastic bags
  - Scissors
  - Radio
  - Flashlight, extra bulbs and batteries

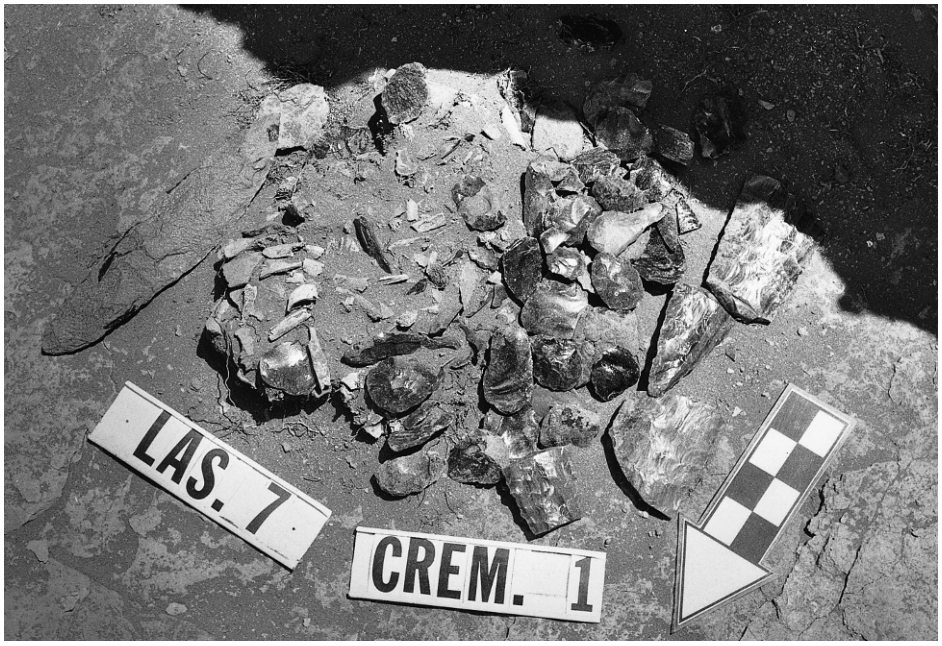



Figure 15.5 **Prehistoric cremation exposed by an archaeological excavation**. Associated with the cremation are obsidian artifacts. The cremated bone fragments are seen in the area above the site name (CA-LAS-7) indicator. Prehistoric, northern California. The scale is in inches.

and head, the depth of the bones from the surface or the datum, and any other contextual details. Take soil samples where appropriate. Photograph and videotape liberally. Remember that all details of context should be retained in an archaeological or forensic excavation. In archaeological situations, context often yields the greatest amount of behavioral information. Excavation of a site destroys it, and contextual data left unrecorded are lost forever.

- Samples for biochemical analyses and histology (see Chapter 22) should be taken at the earliest time, with clean tools and gloves, and in sterile containers, to avoid contamination. See Nielsen-Marsh et al. (2000) for a review of how bone degrades chemically. In order to reduce the amount of "contaminant" DNA (resulting from handling by field and lab workers), some fieldworkers have begun to adopt "clean room" methodology in excavating relatively undisturbed cave sites such as El Sidrón cave in Spain (Pennisi, 2006).
- The actual removal of the bones themselves is one of the last steps of recovery, after exposure, photography, and drawing. To aid in their hardening, let the exposed bones dry completely in an area shaded from the sun. Free each bone gently—do not use force. Matrix (soil or other material that previously encased the bone) may remain on the thin parts (scapula, pelvis) to avoid damage during transport. Do not attempt fine cleaning in the field; this should be performed in situations where light, tools, water, comfort, advice, comparative material, and time are in greater supply — in other words, in the laboratory. Take each bone out individually and place in labeled bags or containers as you go along, particularly the ribs and vertebrae. Keep right and left hands, feet, and rib bones in separate containers. Keep unfused epiphyses with their associated bones. Be observant as you remove the elements, watching for fetal bones, sesamoid bones, kidney and gall bladder stones, and small artifacts. Save everything, even if you think that it might not be human. It is easier to do accurate identification in the laboratory. Do not disregard immature skeletal parts or disturbed burials; such disregard will skew the cemetery representations and ultimately have an adverse effect on any demographic reconstruction.

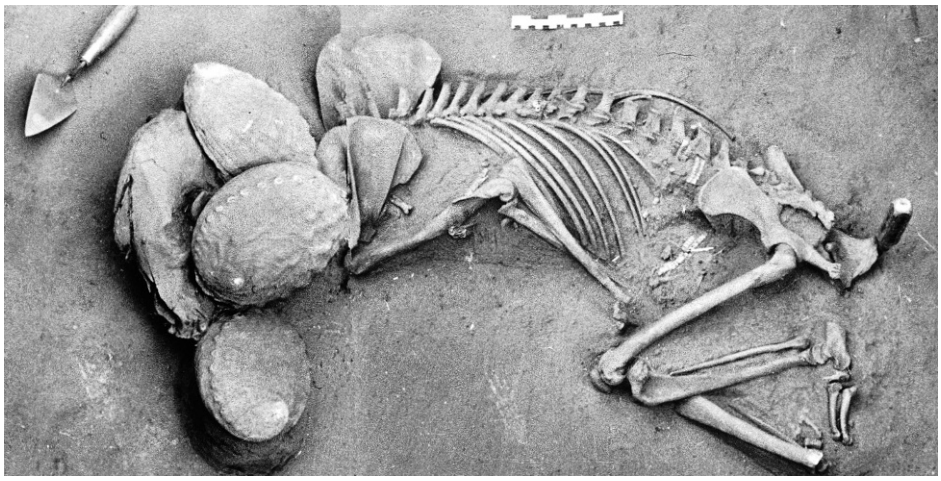
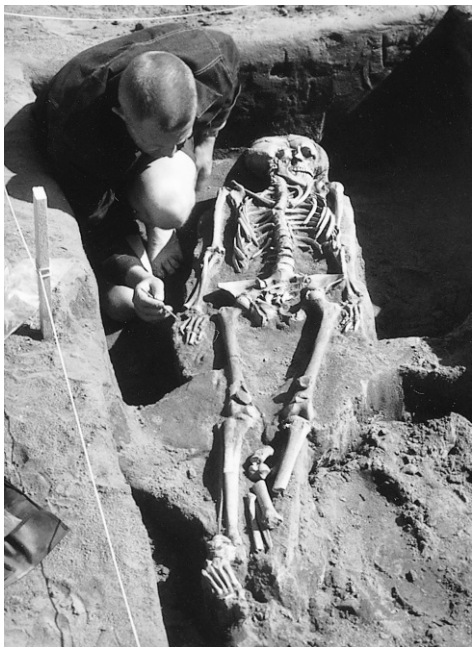


Figure 15.6 **Ceremonial bear burial.** Three large abalone shells cover the skull of the bear. Because the bones of large mammals were usually exploited for their nutritive value, large mammal bones from archaeological refuse deposits are usually very fragmentary; this case is an obvious exception. Prehistoric, northern California. The scale is in inches and centimeters.

- Bag remains as they are found, either in clearly labeled paper bags or in ventilated plastic bags.
- After removal, if the bone is still wet, let it dry completely in the shade. Never mix the specimens during washing or packing at the site. Screen all earth that remains at the spot of the burial, watching for beads, teeth, and other items that may have been missed as the larger bones were removed.
- Decisions about the cleaning of material at the recovery site are best left to the judgment of the investigator. As Brothwell (1981) notes, there is generally no problem in deciding about bone strength; bones are not generally deceptive in this regard. It is usually evident during recovery whether they are likely to disintegrate when handled.
- If the bones need to be cleaned, avoid the once-commonplace act of washing them with water, especially in the field. Water washing bones dissolves and degrades DNA (Pruvost et



Figures 15.7 and 15.8 **An extended burial from a prehistoric site in Ohio.** *Left:* the excavator, having cleared the central part of this burial, carefully exposes the hand phalanges with a dental probe. *Right:* after full recording, the archaeologist carefully removes the ulna and humerus. The ribs have been exposed for photographic recording and drawing, but they were not endangered by undercutting during excavation.

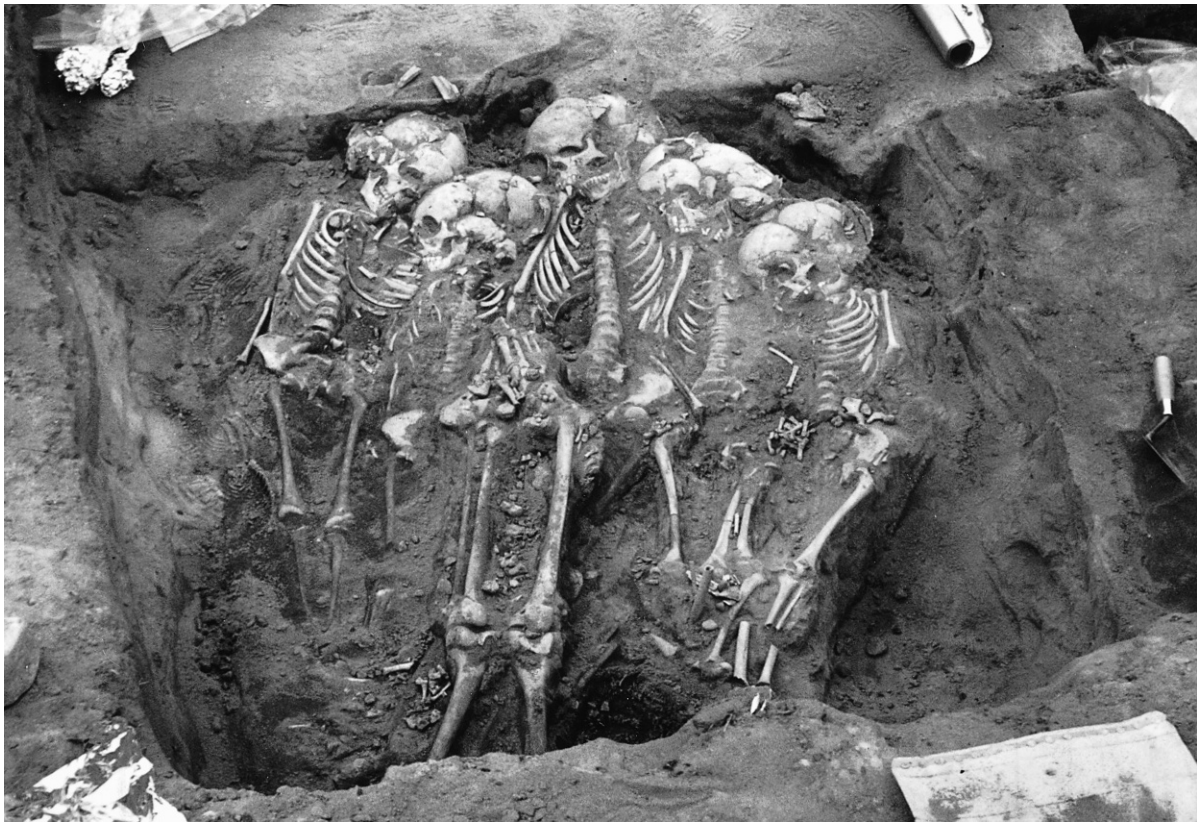


Figure 15.9 **Mass grave at a prehistoric site containing the skeletal remains of four children and an adult.** The legs and feet of a later extended adult burial protrude into the excavation from the bottom of the photograph. Such superimposition of different burial events is commonly encountered in aboriginal cemeteries, usually because graves were not marked with recognizable, surviving surface markers.


Figure 15.10 **Extended burial of an immature individual from a prehistoric site.** Great care must be taken with such young individuals to recover the many unfused bones.


Figure 15.11 **Bones of a fetus were found within the pelvic cavity of this female skeleton from a prehistoric site in Ohio**. The humerus, ribs, and scapula of the fetus are just anterior to the sacroiliac articulation.

al., 2007), may initiate chemical reactions within the bone, and is generally an irreversible, invasive action that should only be done sparingly, after careful consideration, and with proper documentation (Odegaard and Cassman, 2007). If you feel the bones need to be washed, it is best to wait until back in the laboratory.

- It is often best to remove the earth from the cranial cavity and orbits while the soil is still damp. Do not try to reconstruct bones in the field — just keep them together.
- Decisions about the application of preservatives (see Section 16.2) must be made during exposure, and this application will often be necessary before removal is possible.
- Aluminum foil is an inexpensive but very effective material that can be used to stabilize, protect, and keep bones and their parts in place during lifting and transport. Press the foil firmly around all the bone and matrix irregularities.
- Burial recording forms, such as those found in Buikstra and Ubelaker's (1994) Standards volume, should be used. These can be useful, provided that caution is used in determining sex, age, and other features often prompted by such forms. Be sure to mark these determinations of identity as preliminary when they are made under field conditions.

## 15.4 Transport

When exposure, stabilization, photography, and drawing are complete, the skeletal remains may be removed from the archaeological context. In a forensic context, the decision to remove is made by the chief of the crime scene. This begins a "**chain of custody**," a formal process in which the osteologist must participate, and should also document in writing (Melbye and Jimenez, 1997). If the bone is well-preserved, the elements can be lifted individually. Once bones have been extracted and field-cleaned, they are ready for packing and transport to the laboratory. Available

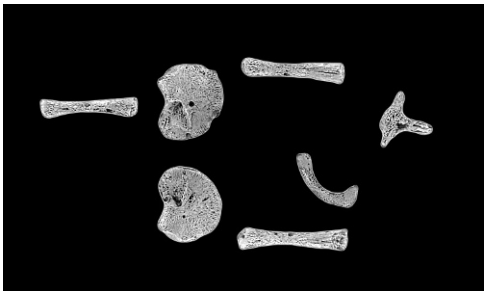


Figure 15.12 **This fetal skeletal material from a prehistoric site in Ohio represents one of the smallest burials ever recovered.** Good preservation combined with great concern for detail during excavation made the skeletal collection from this archaeological site one of the best available for the study of prehistoric demography (see Chapter 21). Natural size.

vehicles and packing materials for transport vary greatly. However, under all conditions, one primary rule should always be observed: *Do not let any further damage, contamination, or mixing occur.*

Occasionally it is necessary to remove the burial or its parts as a unit, in a supporting block of matrix, for study or display. To remove an entire burial, employ the paleontological technique of jacketing. To do this, first isolate the specimen on a pedestal of earth. Cover the exposed areas with tissue paper or polyethylene cling film to protect the bones and to act as a moisture barrier. Next, soak Orthoplast® bandages in water and then use them to form a cast or jacket around the specimen. Reinforce this jacket as necessary with additional plaster and, if necessary, strengthening rods of metal or wood. After the plaster has hardened, undercut the specimen and lift it out. This is an expensive operation in terms of material, time, and personnel. It requires experience and should be used only when necessary.

Once the burial has been removed, cleaned, and dried, the hands, feet, and ribs should be bagged by side, and the vertebrae by type. Labeling these elements at the time of removal greatly facilitates later sorting in the laboratory. Fine cleaning and gluing should be left for the laboratory. Label all bags and boxes used for collection with waterproof ink. Paper bags are prone to deterioration if used for long-term storage, but they breathe moisture, and are therefore better than plastic bags for post-excavation sorting, and for transport of skeletal material that retains residual moisture. In transport, keep the bones away from water. It is very important to carefully label and maintain organization when the bones are extracted from their context and moved to the laboratory.

When packing bones, pack firmly with lots of padding (plastic bags, bubble wrap, or newsprint) to avoid movement in the container. Pack heavier, denser bones at the bottom of containers and the more fragile bones such as scapula, pelvis, and crania at the top. Be sure that all bones stay in their assigned containers during the jostling that inevitably accompanies transport. Be particularly careful with the cranium, which is fragile in the facial regions. The cranium and mandible should each be packed separately, and care should be taken to ensure that teeth do not dislodge from their sockets during transport.

## Suggested Further Readings

Some additional published sources describing skeletal recovery in archaeological and forensic contexts are provided here. Note that there is no written substitute for experience; the inexperienced osteologist charged with retrieving skeletal remains should always enlist the aid of more experienced colleagues, particularly archaeologists.

Adams, B. J., and Byrd, J. E. (Eds.) (2008) *Recovery, analysis, and identification of commingled human remains.* Totowa, NJ: Humana Press. 374 pp.

This edited volume presents many of the methodological approaches that can be used when dealing with commingled remains.

Blau, S., and Ubelaker, D. H. (Eds.) (2008) *Handbook of forensic archaeology and anthropology.* Walnut Creek, CA: Left Coast Press. 800 pp.

A large volume containing over 40 chapters and covering the history, current practice, and future directions of forensic anthropology from a global perspective.

Brothwell, D. R. (1981) *Digging up bones* (3rd ed.). Ithaca, NY: Cornell University Press. 208 pp.

A classic in the field; chapter 1 discusses excavation of skeletal material in archaeological context.

Connor, M. A. (2007) *Forensic methods: Excavation for the archaeologist and investigator.* Lanham, MD: AltaMira Press. 272 pp.

Chapters 3–12 (and the appendices) are useful for their coverage of methodology.

Dupras, T. L., Schultz J. J., Wheeler, S. M. and Williams, L. J. (2005) *Forensic recovery of human remains: Archaeological approaches.* Boca Raton, FL: CRC Press. 232 pp.

A guide to the application of modern archaeological field techniques to forensic excavation and recovery of human remains and associated evidence.

Haglund, W. D., and Sorg, M. H. (Eds.) (1997) *Forensic taphonomy: The postmortem fate of human remains.* Boca Raton, FL: CRC Press. 636 pp.

An excellent edited volume with reviews and case studies covering a wide array of topics.

Hunter, J., and Cox, M. (Eds.) (2005) *Forensic archaeology: Advances in theory and practice.* New York, NY: Routledge. 256 pp.

An introduction to the history and methodology of forensic archaeology, including its relationship to forensic anthropology.

Killam, E. W. (2004) *The detection of human remains* (2nd ed.). Springfield, IL: C. C. Thomas. 268 pp.

The most comprehensive guide available; even has a chapter on "parapsychological methods."

Kipfer, B. A. (2007) *The archaeologist's fieldwork companion.* Malden, MA: Wiley-Blackwell. 488 pp.

This handy guide serves as an introduction to the forms, procedures, and terminology common in North American archaeology. Chapter 4 ("Mapping, Drawing, and Photographing") and the many checklists are particularly helpful.

Komar, D. A., and Buikstra, J. A. (2007) *Forensic anthropology: Contemporary theory and practice.* New York, NY: Oxford University Press. 384 pp.

An up-to-date guide to practicing forensic anthropology in the U.S. Includes case studies, a comprehensive bibliography, and an extensive glossary.

Leiggi, P., and May, P. J. (Eds.) (1994) *Vertebrate paleontological techniques: Volume 1.* Cambridge, UK: Cambridge University Press. 344 pp.

A guide to a variety of standard field and laboratory techniques used by vertebrate paleontologists.

Schmidt, C. W., and Symes, S. A. (Eds.) (2008) *The analysis of burned human remains.* Burlington, VT: Academic Press. 296 pp.

A guide to the changes seen in bones and teeth as a result of being subjected to fire.

Williams, E. (Ed.) (2001) *Human remains: Conservation, retrieval and analysis.* Oxford, UK: Archaeopress. 281 pp.

The papers in this edited volume comprise a diverse set of viewpoints on the appropriate scientific and educational use of archaeological human remains. The numerous case studies from around the world illustrate ways of balancing the tension inherent in work involving these remains.